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**Keywords:** Diabetes mellitus, glycated haemoglobin, public sector, glycaemic control

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**Management of patients with type 2 diabetes mellitus at a district hospital in Gauteng, South Africa: a retrospective review of patient medical records**

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## Abstract

***Introduction:*** *Diabetes mellitus (DM) is a major health concern in South Africa and worldwide. Chronic condition management is guided by the Standard Treatment Guidelines (STGs) of South Africa. This study aimed to investigate the compliance to the STGs by health professionals, in managing patients with Type 2 diabetes mellitus (T2DM) attending a district hospital in Gauteng and to determine the extent of glycaemic control for these patients.* ***Methods:*** *a retrospective review of randomly selected selected medical records of patients with T2DM who accessed care between June 2022 and May 2023 from a district hospital's outpatient department (OPD) was conducted. Demographic data were recorded. Clinical data recorded included random blood glucose (RBG) levels, glycated haemoglobin (HbA1c), blood pressure (BP), body mass index (BMI) and weight.* ***Results:*** *Mean age of patients was 59.3 years (± 12.4) of whom 55.6% were female (n=153). Females were 55.6% and males were 44.4%, (n=153). Six (3.9%) patients had no co-morbid conditions and 147 patients (96.1%) had at least one or more co-morbidities. During the one-year study period, HbA1c was measured once in 69.3% (n=106) of patients. Of these 106 patients, only 16% (n=17) achieved glycaemic targets. Random blood glucose levels and BP were checked at each clinic visit. Exclusive oral hypoglycaemic treatment (57,5%), exclusive insulin therapy (5.9%) and combination therapies (36.5%) were prescribed.* ***Conclusion:*** *the study demonstrates unsatisfactory compliance to treatment guidelines at this hospital and highlights the need to review the implementation of the treatment guidelines in public sector facilities in South Africa.*

## Introduction

South Africa has tiered levels of healthcare provision in the public sector. District health services comprising Primary healthcare (PHC) clinics, Community health centers (CHCs) and district hospitals [1]. District hospitals are key in the referral system in South Africa, bridging the gap between PHC clinics, CHCs, regional and tertiary levels of healthcare [2]. The treatment and management of prevalent health conditions in the South African public healthcare sector are standardized through the implementation and use of Standard Treatment Guidelines (STGs) [3]. These evidence-based guidelines emphasize effective strategies for monitoring and treating priority diseases afflicting the population [3]. Diabetes mellitus (DM) is one of these priority health diseases.

Diabetes mellitus (DM) is a chronic endocrine disorder characterized by persistently elevated blood glucose levels, abnormal metabolism of carbohydrates, fats and proteins [4]. Type 2 Diabetes Mellitus (T2DM) is the most prevalent type of diabetes, attributing to a more than 90% incidence in sub-Saharan Africa [7]. Diabetes mellitus (DM) affects an estimated (37 million people worldwide [5]. In South Africa, the number of people with diabetes has more than doubled from 1.9 million in 2011 to an estimated 4.2 million in 2021 [5]. It is reported that DM is among the leading causes of mortality and morbidity in South Africa [6]. Early detection of DM, appropriate diagnosis, treatment, access to medication, effective management of co-morbidities, consistent screening and early identification of diabetic complications are all crucial factors in the management of the disease [7].

Compliance to treatment guidelines, by healthcare providers, when managing patients with DM reduces the complications due to the disease, also reducing the cost of care [8]. Compliance can be classified as implementing monitoring assessments and following the recommended pharmacological treatment. Insight into the management of patients with T2DM could have a positive impact on how T2DM is treated and managed at a district hospital level of care. Determining the extent of glycaemic control in patients with T2DM at this level of care is imperative to reduce the burden and cost of care.

Presenting research-based information of the treatment outcomes of those patients could have a positive impact on how T2DM is treated and managed in the future. Thus, this study aimed to assess whether healthcare professionals in a district hospital in Gauteng, comply with the recommended treatment and monitoring practices, for patients with T2DM.

## Methods

**Study design and setting:** a quantitative, retrospective record review of medical files of patients with established T2DM was undertaken to determine whether the management of patients at a district hospital was aligned to the STGs of South Africa. The study was conducted at the Out-patient department (OPD) of a district hospital situated in the Gauteng province of South Africa. The selected study site is a 300 bedded level one hospital. District hospitals are the first level of hospital care in the South African public health referral system.

**Study population:** the study population was patients with a diagnosis of T2DM who had a minimum duration of diabetes of one year. Included in the study were data from hospital files of patients older than 18 years, who received care and treatment for T2DM at the OPD between 01st June 2022 and 31st May 2023. Patients diagnosed with type 1 DM and pregnant women with gestational diabetes, were excluded from this study. A sample size of 143 patient medical records was derived by using the following formula:

$$n = \frac{Nx}{((N-1)E^2+x)}$$

Where: *n* is the sample size, which is the point of interest; E is the margin of error = 0.05; N is the population size = 226; x is the observed sample mean.

The estimated sample size was adjusted to factor in incomplete data from patient medical records. A total of 156 patient medical records were randomly selected for this study. The sample size of the patient medical records was achieved by identifying the records of all patients with a diagnosis of T2DM. The records were then randomly selected using a systematic sampling technique, where every third patient record was selected until the desired sample size was achieved.

**Data collection:** demographic data including sex and age, clinical and laboratory measurements were collected from the physical patient medical records and recorded onto a predesigned data collection tool. The data collection tool was divided into three sections, where the first section consisted of the demographic and clinical data of the study population. Clinical data included Random blood glucose (RBG) levels, Blood pressure (BP) measurement, weight, Body mass index (BMI), Glycated haemoglobin (HbA1c), waist circumference, serum creatinine and potassium levels. The second section was used to record yes or no responses, with regards to whether the recommended monitoring assessments as per the STGs were performed at least once during the study period between June 1, 2022 and May 31, 2023. The third and final section was used to record the pharmacological treatment regimens, including the prescribed dose and dosing intervals. Data were collected over a four-week period, where an average of ten patient medical records were selected and analyzed per day, for four days in a week. The measurements recorded were readings from any three consecutive clinic visits, recorded in the patient medical files between June 1, 2022 and May 31, 2023. Pharmacological treatment regimens for the same period were also recorded.

**Definitions:** key variables for this study comprised two types of variables, quantitative (continuous) variables and qualitative (categorical) variables. The continuous variables were age, RBG, BP, weight, BMI and HbA1c. The categorical variables were gender and treatment regimens. Primary outcomes were: 1) whether annual monitoring

assessments were performed at least once in the 12-month study period; 2) whether the pharmacological treatment guidelines were adhered to by the healthcare professionals when treating patients with T2DM and 3) whether there was evidence of glycaemic control, using the HbA1c level as an indicator.

**Statistical analysis:** statistical analysis of the data was done using the analytics software package, TIBCO Statistica® version 14.0.1. Data was checked for completeness and cleaned using Microsoft Excel®. Data from three patient medical records were excluded from the analysis, one was due to duplication and the other two due to incomplete data, with no single test recorded. A total of 153 medical records were analyzed in this study. Statistical analysis of the results was presented as frequencies and percentages, for categorical variables. Continuous variables were presented as means and standard deviations, as well as medians and Interquartile ranges (IQR). Comparisons between continuous variables was done using parametric t-tests.

**Ethical considerations:** ethical approval for this study was obtained from the Human Research Ethics Committee (HREC) of the University of the Witwatersrand (Clearance Certificate Number M230665 MED23-05-105). Written approvals were obtained from the Head of Department (HoD) of the OPD, the clinical manager of the hospital and the District Research Committee. The study did not require consent to participate from individual participants because patients were not being recruited for the study, only medical records were retrieved and used to collect data. No patient identifiers were used in the recording of the data.

## Results

**Characteristics of the study population:** a total of 153 medical records of patients with T2DM were reviewed retrospectively for this study. The patients were between 27 and 90 years old, with a mean age of 59.3 years (± 12.4) (Table 1). Proportion of females and males was 55.6% and 44.4% respectively. Only 6 patients (3.9%), had no comorbid conditions and the remaining 147 patients (96.1%), had at least one or more comorbidities. Hypertension and hypercholesterolemia were the most common co-morbidities, with 133 (86.9%) of the study population presenting with hypertension and 86 (56.2%) presenting with hypercholesterolemia as documented in the patient medical records. Complete list of comorbidities among the study population is illustrated in Figure 1.

**Medications:** a total of 88 patients (57.5%) were exclusively on oral medication, nine patients (5.9%) were on insulin only therapy, and the remaining 56 patients (36.6%) were treated with a combination of oral medication and insulin. Metformin was prescribed for 143 (93.5%) of the patients, as monotherapy or combination therapy including a sulphonylurea with or without insulin. Second line treatment of metformin with a sulphonylurea was prescribed for 39 (25.5%) of patients. The most common co-prescribed medicines included diuretics, lipid lowering agents, Angiotensin converting enzyme inhibitors (ACE-inhibitors), Calcium channel blockers (CCB), aspirin and beta blockers. A complete list of the co-prescribed medicines is shown in Figure 2. Pharmacological management of T2DM is set out in the STGs in a stepwise approach. The results show compliance to treatment guidelines in 138 (90.2%) patients.

**Clinical and laboratory data:** the HbA1c levels for 106 patients (69.3%) were recorded. Patients with HbA1c levels available at the first visit during the study period had a mean HbA1c of 10.7% (± 3.8), a median of 9.6% and Interquartile range (IQR) of (7.7, 13.4) (Table 2). The patients were classified according to patient type, as stipulated in the STGs, as follows, the young low-risk patients with no Cardiovascular disease (CVD) (n=8), the elderly high-risk patient (n=50) and the majority of the patients (n=48). The proportion of patients that achieved glycaemic targets (HbA1c) were as follows: the young, low-risk patients, 1 (12.5%), achieved the target of < 6.5%, the elderly high-risk

patients, 11 (22%) achieved the target of < 7.5% and only 5 (10.4%) of the patients, that do not fall into the two categories mentioned, achieved the glycaemic target of less than 7%, which is the recommended target for the majority of patients. Figure 3 depicts the ranges of the first HbA1c levels taken for all 106 patients at the first visit. All 153 patient medical records had three consecutive RBG levels and BP measurements available, which were taken at each clinic visit, as is required in the STGs (Table 2). Blood lipid profiles were done for 114 (74.5%) patients, once during the one-year study period. The complete clinical and laboratory data is shown in Table 2.

**Clinical assessments:** the assessments that were done for the majority of the patients were serum creatinine 121 (79.1%), serum potassium 122 (79.7%) and blood lipid profiles 114 (74.5%). Other assessments that were recorded were foot examination, which was done on 13 (8.5%) of the patients and a resting Electrocardiogram (ECG) which was done on 60 (39.2%) of the patients. Urinalysis findings were documented in 82 (53.6%) patient medical records. Glycosuria was recorded for 22 (27.2%) of the patients, while ketonuria was documented for 2 patients (2.5%). Only 3 patients (2%) had an oral and dental examination performed within the twelve-month study period. Eye examination was recorded in 23 patients (15%). Assessment for peripheral neuropathy was done on 28 patients (18.3%). According to the STGs of South Africa, a total of nine assessments must be done annually as part of monitoring patients with T2DM, for microvascular and macrovascular complications. The results indicate that none of the 153 patients had all nine assessments performed in the twelve-month study period and 9 (5.9%) of the patients had no single assessment done in the twelve-month study period.

## Discussion

This retrospective study set out to assess the compliance by healthcare professionals, to treatment and monitoring guidelines, as set out in the STGs of South Africa, in the management of adult patients with T2DM receiving care at a district hospital and the extent of glycaemic control among patients with T2DM. Compliance to the STGs for the treatment of diabetes was demonstrated by the healthcare personnel. The results indicate that pharmacological treatment was in line with the STGs of South Africa for 138 (90.2%) of the patient prescriptions. The majority of patients being treated with metformin 143 (93.5%) as monotherapy or combination therapy, which is in line with the current STGs in diabetes management, indicates compliance by prescribers to the stepwise approach in the pharmacological management of patients with T2DM. However, clinical management, including monitoring assessments, indicated poor compliance to the STGs, identifying several areas of improvement. Examinations as per the guidelines, such as oral and dental examination (n= 3, 2%), eye examination (n=23, 15%), assessment for peripheral neuropathy (n=28, 18.3%) and foot examination (n=13, 8.5%), , were performed in a small number of patients during the one-year study period. Blood glucose levels and BP measurements were performed routinely in every patient, at each clinic visit, indicating compliance to recommended guidelines. Poor compliance to screening and testing protocols by medical personnel amplifies the risk of patients developing diabetic complications [8]. In addition, data from this study indicates that only 16% of patients achieved the recommended targets of HbA1c levels.

The recommendation according to the available treatment guidelines, is for the majority of patients with T2DM, to be controlled at HbA1c levels of < 7%. The HbA1c levels of patients with DM should be checked on a regular basis, as it is a good indicator for glycaemic control and enables healthcare providers to predict complications [9]. In patients who meet treatment goals, HbA1c levels must be checked every six months and in patients whose control is sub-optimal or if therapy has been changed, HbA1C must be checked every

three months, until the patient is stable [10]. Other studies from South Africa have reported disappointing findings, with as few as 15.6% or less of patients achieving the target of HbA1c < 7% [11]. Pillay *et al.* also found that only 11.8% of the patients with T2DM achieved optimal blood glucose control [12].

Achieving good glycaemic control is of paramount importance. Evidence shows a 2.5 to 5-fold increase in the risk of developing microvascular complications in patients with T2DM with HbA1c values >7.5% [13]. In the same patients, the risk of developing peripheral arterial disease shows a 5-fold greater risk [13]. The entire study population was receiving the recommended pharmacotherapy of glucose-lowering agents; however, glycaemic control was poor. The results from this population emphasize that glycaemic control is not determined by adequate access to pharmacotherapy only [14]. Poor glycaemic control could be indicative of patient-related factors such as compliance issues to prescribed dietary and lifestyle modifications [15]. This highlights the need by medical professionals to strengthen medication education and look closely into issues that inform patient compliance, such as medication side effects and patient preferences, outside the scope of this study [15].

Glycaemic control is not the only goal in the treatment of DM; treatment and control of other cardiovascular risk factors is also crucial [7]. Hypertension is one of the most serious, life-threatening risk factor for the development of CVDs [11,16]. In this study 133 (86.9%) patients had documented hypertension. These results are similar to other local studies: Pinchevsky *et al.* had 88.4% (Johannesburg, South Africa) and Piotie *et al.* had 82.7% (Tshwane, South Africa) of patients with documented hypertension. Despite receiving BP lowering medication, the results from this study indicate that treatment goals were only met in seven (4.6%) patients, the implications of such findings are suggestive of the fact that those patients who did not meet treatment goals are at risk of developing CVDs.

Available guidelines recommend that foot examinations be performed annually in all patients. The findings from this study are similar to a 2018 study performed in Kwa-Zulu Natal, which showed only 7.8% of the patients had a foot examination conducted [17]. Building onto this evidence of poor foot examination in patients with DM, Amod *et al.* found that only 6% of the patients had a documented foot examination [18]. This is concerning considering the guidelines clearly stipulate that all patients with T2DM should have a foot examination performed annually, to determine their risk of developing foot ulcers [18]. Previous studies have also shown that diabetic foot ulcers account for approximately 85% of amputations, attributed to DM [19]. The high incidence of amputations, largely due to DM, pose a financial burden on the healthcare system and a psychological burden on the patients and their families [20]. In order to minimize the risk to the patients, it is crucial for healthcare professionals to perform regular foot examinations on all patients with DM. Oral and dental examination was sub-optimal considering these monitoring tests are clearly stipulated in the STGs. There could possibly be a lack of understanding of the relationship that exists between hyperglycaemia and oral health. People with DM are generally at a greater risk of developing oral diseases and this risk is further increased in patients with poorly controlled DM [21].

Limitations of this study included the fact that some of the medical records had missing data on weight, BMI and waist circumference. The study was conducted in one district hospital in an urban setting and therefore the results may not necessarily be applicable to all patients with T2DM across South Africa. The findings of the compliance practices of the healthcare professionals are limited to this one specific district hospital and not representative of all healthcare professionals across South Africa. Other factors determining glycaemic control, such as adherence to treatment and dietary recommendations were not addressed, as they are beyond the scope of this study.

## Conclusion

The study assessed compliance to the recommended STGs of South Africa, by healthcare personnel, in the treatment and management of patients with T2DM and the extent of glycaemic control in those patients being managed in a public healthcare setting. The findings from this study site indicate poor compliance to monitoring interventions recommended in the STGs. This could result in complications being identified late, leading to poor outcomes for patients and an increased burden of care. If diabetic complications are to be minimized and health outcomes improved, vigorous monitoring and screening strategies need to be implemented. Findings from the study indicate 90.2% compliance to recommended pharmacological treatment guidelines. However, this finding indicates that access to the correct pharmacological treatment does not automatically translate into optimal glycaemic control. A myriad of other factors, beyond the scope of this study, which are worthy of further investigation, may impact achieving the recommended glycaemic targets.

***What is known about this topic***

- *Compliance to monitoring strategies by healthcare personnel in the management of patients with DM are not satisfactory;*
- *Adequate glycaemic control is not only determined by access to appropriate treatment, but also influenced by patient-related factors and socioeconomic factors;*
- *South Africa's public healthcare system is plagued by resource shortages and the diabetes burden further adds to the already high cost of care.*

***What this study adds***

- *The study adds to the evidence that STGs are not being complied to in the management of patients with chronic conditions in public healthcare facilities;*
- *Continuous professional education, for healthcare personnel, in the management of chronic conditions can have a positive impact on health outcomes of patients with T2DM;*
- *This study adds to the evidence that appropriate management of diabetes is important in reducing the cost of care on the healthcare system.*

## Competing interests

The authors declare no competing interests.

## Authors' contributions

Conception and study design: Razeeya Khan, Amber Cheng, Ané Orchard, Muhammed Vally and Shingairai Dewah. Data collection: Shingairai Dewah. Data analysis and interpretation: Shingairai Dewah. Manuscript drafting: Shingairai Dewah. Supervision: Razeeya Khan, Amber Cheng, Ané Orchard and Muhammed Vally. Manuscript revision: Razeeya Khan, Amber Cheng, Ané Orchard and Muhammed Vally. All authors read and approved final version of the manuscript.

## Tables and figures

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**Table 2**: clinical and laboratory data

**Figure 1**: associated comorbidities among patients with type 2 diabetes mellitus

**Figure 2**: co-prescribed medications among patients with type 2 diabetes mellitus

**Figure 3**: glycated haemoglobin values among patients with type 2 diabetes mellitus

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**Table 1:** demographic data of patients with type 2 diabetes mellitus (N=153)

| **Variables** | **Categories** | **n** | **%** |
|---|---|---|---|
| Age (years) | ≤ 30 | 3 | 2.0 |
| | 31-40 | 10 | 6.5 |
| | 41-50 | 19 | 12.4 |
| | 51-60 | 52 | 34.0 |
| | 61-70 | 39 | 25.5 |
| | ≥ 70 | 30 | 19.6 |
| Sex | Female | 85 | 55.6 |
| | Male | 68 | 44.4 |
| Comorbidities | Yes | 147 | 96.1 |
| | No | 6 | 3.9 |
| No. of other conditions | 0 | 6 | 3.9 |
| | 1 | 49 | 32.0 |
| | 2 | 83 | 54.2 |
| | 3 | 15 | 9.8 |

| **Table 2:** clinical and laboratory data | | | |
|---|---|---|---|
| Variable | **1st Visit** | **2nd Visit** | **3rd Visit** |
| **Random blood glucose (mmol/L) (n=153)** | | | |
| Mean ± SD1 | 11.7 ± 5.27 | 10.9 ± 5.21 | 11.1 ± 4.4 |
| Median (IQR)2 | 10.9 (7.3, 15.2) | 9.8 (7.2, 13.8) | 10.4 (7.8, 13.5) |
| **BMI3 (kg/m²) (n = 25)** | | | |
| Mean ± SD | 32.3 ± 8.4 | | 24.3 ± 1.63 |
| Median (IQR) | 31.4 (25.7, 38.2) | | 24.3 (23.1, 25.4) |
| Not recorded | 130 | 153 | 151 |
| **Systolic BP4 (mmHg) (n = 153)** | | | |
| Mean ± SD | 143 ± 21.4 | 141 ± 21.0 | 142 ± 19.9 |
| Median (IQR) | 142 (126, 154) | 140 (125, 152) | |
| **Diastolic BP (mmHg) (n = 153)** | | | |
| Mean ± SD | 83 ± 13.8 | 85 ± 13.1 | 83 ± 12.1 |
| Median (IQR) | 82 (74, 92) | 84 (77, 92) | 84 (76, 90) |
| **HbA1c5 (%) (n = 106)** | | | |
| Mean ± SD | 10.7 ± 3.8 | 9.4 ± 2.7 | |
| Median (IQR) | 9.6 (7.7, 13.4) | 9.2 (7.4, 10.5) | |
| Not recorded | 47 | 132 | 153 |
| **Annual value** | | | |
| **Serum Potassium (mmol/L) (n = 122)** | | | |
| Mean ± SD | 4.29 ± 0.65 | | |
| Median (IQR) | 4.2 (4.0, 4.5) | | |
| Not recorded | 31 | | |
| 1SD., standard deviation; 2IQR., interquartile range; 3BMI., body mass index; 4BP., blood pressure; 5HbA1c., glycated haemoglobin | | | |

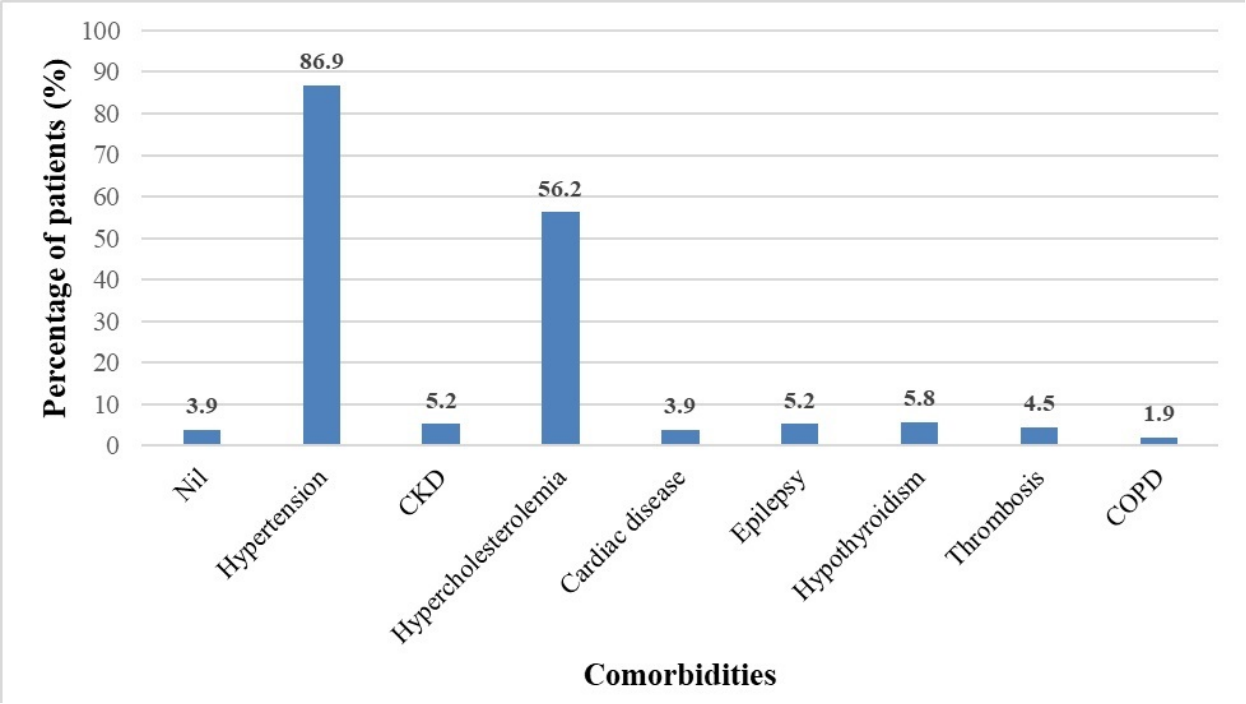



**Figure 1**: associated comorbidities among patients with type 2 diabetes mellitus

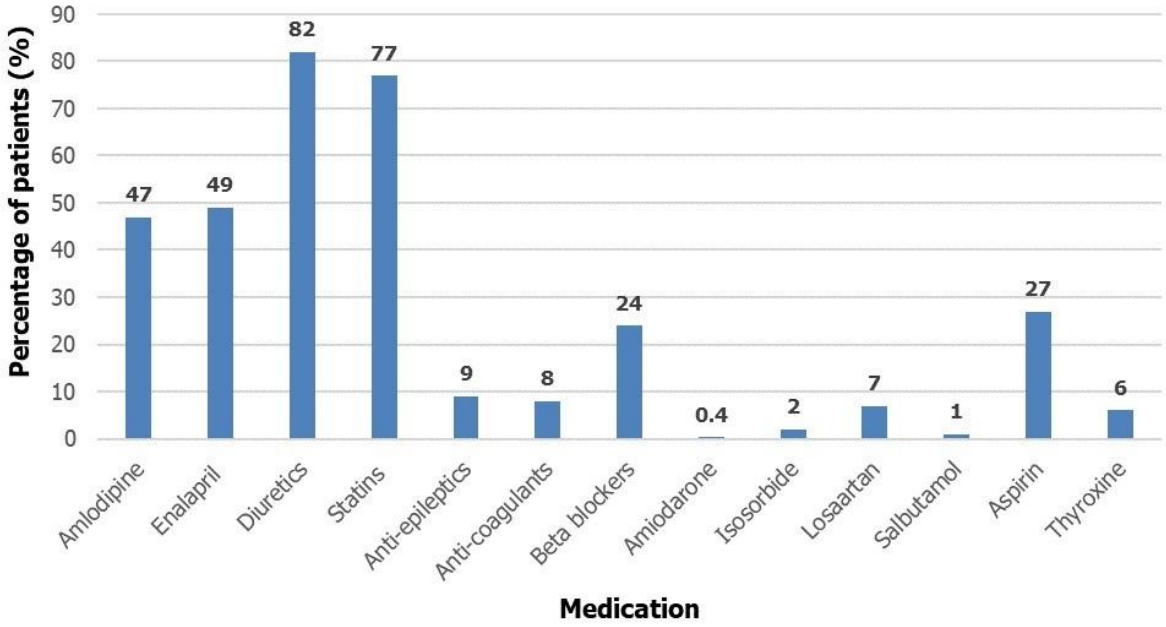



Figure 2: co-prescribed medications among patients with type 2 diabetes mellitus

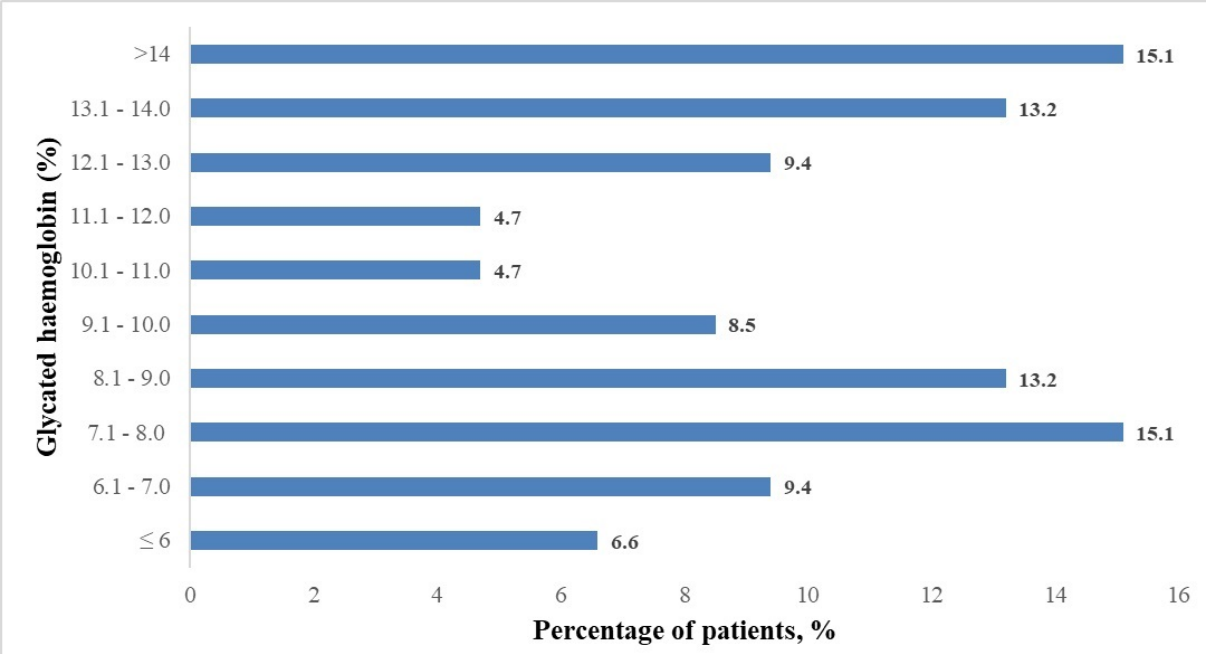



**Figure 3:** glycated haemoglobin values among patients with type 2 diabetes mellitus